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STUDENT
MANUAL

TAG

"TAGGING AND RECOVERY" METHOD FOR WILDLIFE POPULATION STUDY

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HUNTINGTON TWO COMPUTER PROJECT

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TAG

STUDENT MANUAL

Table of Contents

I. The *TAG* Experiment 1

II. Running the *TAG* Program 5

III. Preparations for *TAG* 8

I. THE *TAG* EXPERIMENT

In this computer simulation, you are faced with the problem of determining the approximate bass population in a warm-water, bass-bluegill farm pond. In a real situation, it might be possible to count all the fish directly by draining the pond or removing all the fish from the pond. In either case, many of the fish would die and the ecology of the pond would be seriously altered.

In order to obtain a reliable estimate of a fish population without harming the fish or severely altering pond ecology, scientists have developed the technique of tagging and recovery. *Tagging* is the simple process of attaching a disk-type tag or an internal anchor-type tag to a fish. Fish that are to be tagged usually come from a hatchery or are trapped. The tagged fish are released into the farm pond where they are allowed to mix with untagged fish. After time has been allowed for this mixing to occur, a sample fish is caught and inspected for the tag. After each fish is captured and examined, it is returned to the pond. Taking the sample fish from the pond is called *recovery.*

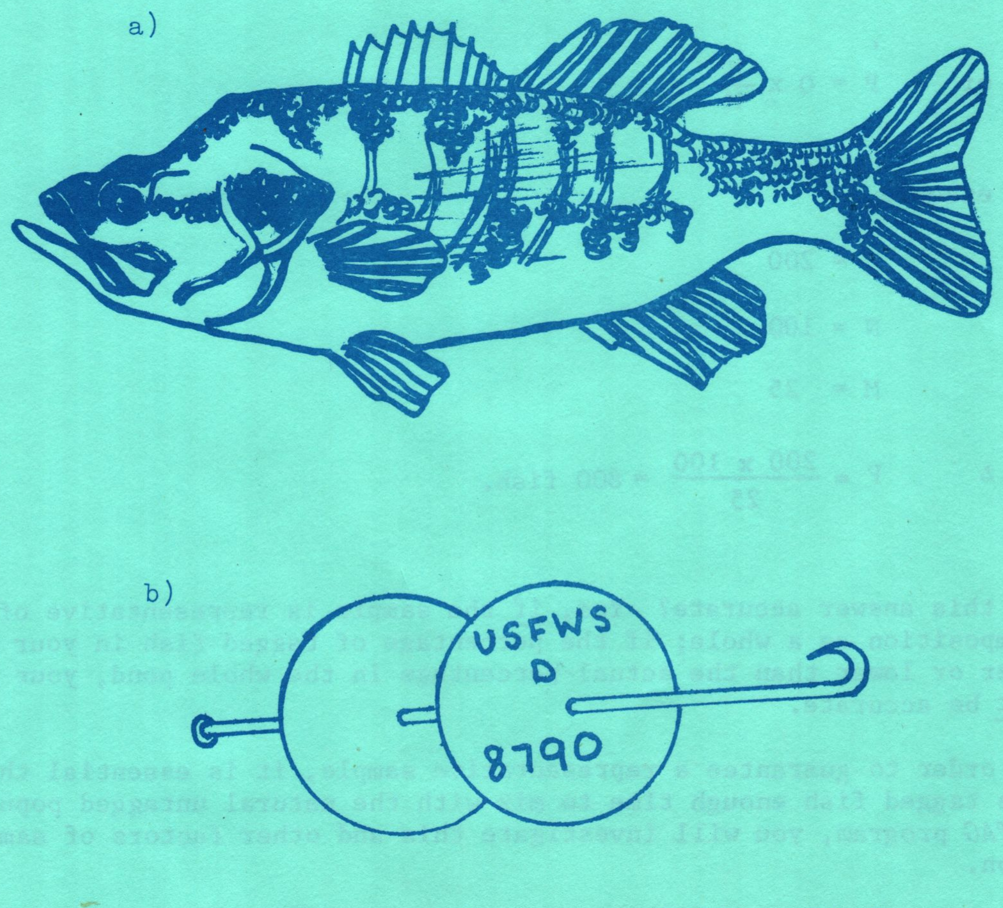


Figure 1 -- a) Large-mouthed bass; b) disk tag

How can sample-taking be used to find the total pond population? Consider the following example of a tagging and recovery experiment:

> Suppose we receive 200 tagged bass from a hatchery and release them into the pond. We wait several days for the tagged and untagged fish to mix and, after the diffusion has occurred, we take a sample of 100 fish. The sample consists of 25 *tagged* bass and 75 *untagged* bass. Now, how do we figure out how many bass are in the pond?

You could solve the problem in the following way:

> Based on your sample, 1/4 of the fish are tagged. Since there are 200 tagged fish (that's the number we put in), the total number of fish in the pond must be 4 times that number or a total of 800 fish.

If this informal solution leaves you dissatisfied, you might try a more formal approach; the following solution utilizes the concept of proportions:

$$\frac{Q \text{ (tagged fish in pond)}}{P \text{ (total number of fish in pond)}} = \frac{M \text{ (tagged fish in sample)}}{N \text{ (number of fish in sample)}}$$

or $$P = Q \times \frac{N}{M}$$

For our example,

$Q = 200$

$N = 100$

$M = 25$

$$\therefore \quad P = \frac{200 \times 100}{25} = 800 \text{ fish.}$$

Is this answer accurate? Yes, if the sample is representative of the pond composition as a whole; if the percentage of tagged fish in your sample is higher or lower than the actual percentage in the whole pond, your answer will not be accurate.

In order to guarantee a representative sample, it is essential that you give the tagged fish enough time to mix with the natural untagged population. In the *TAG* program, you will investigate this and other factors of sample selection.

In the next section there is a description of the *TAG* program. If you feel that you understand the tagging and recovery technique and the proportions formula, you can proceed to the *TAG* program. If you still have questions, or if the technique still seems somewhat mysterious, then you should work through the following exercise. Even if you're confident about the proportions formula, you might work out the exercise. It's easy to do, and it probably will give some insight into the more general nature of sampling problems.

Preparation Exercise: *The Bean Seed Problem*

Fill a pint container approximately one-half full of bean seeds.

1) Devise as many ways as you can for estimating the number of bean seeds in the container. For each method that you devise, compute an estimate of the number of bean seeds in the container.

2) Do you think that any of the methods which you used in (1) could be used to estimate the fish population in a farm pond without altering the ecology of the pond? Explain.

Now add 20 bean seeds that have been marked (use nail polish, paint, ink,etc.) to the bean seeds already in the container. By marking the beans, you ensure that they are the same volume and density as the original beans. Why is this important? Shake the container vigorously to mix the bean seeds.

3) Cover your eyes and draw out 20 bean seeds from the container. Use the proportions formula $Q/P = M/N$ given on page 2 to estimate the total bean-seed population in the container. (Before you can do this, you will need to define P, Q, N, and M for this problem.)

4) Repeat the procedure in (3) three more times, then find an average of the four estimated values for P.

5) Now repeat the procedure described in (3) with the following change: after the first bean seed is drawn from the container, record whether or not it is marked, then return it to the container and shake the container well. Repeat this process until the results of 15 drawings have been recorded. Now use the formula to determine the bean-seed population of the container.

6) Repeat the procedure in (5) three more times; then find an average of the four values for P.

7) Now count the number of beans in the container. Which population estimate was the most accurate?

8) In view of your answers to (3), (4), (5), and (6), discuss each of the following questions:

   a) Do you think the results would have been different if the number of marked beans had been larger? smaller?

   b) Compare your results with those of one of your classmates who used a container with a different shape. How do you think the shape of your container might have affected your results?

   c) Suppose you had emptied the beans into a container with a surface area such as a pie tin. How would you have altered your technique for drawing out beans and shaking the container? Why? Do you think your reasoning will apply to the farm-pond problem? Discuss.

   d) If you had dropped your container of beans and in the recovery of them missed a few, how great an effect do you think this would have on your results? Can you see a possible comparison between this situation and the mortality rate for tagged fish in the farm pond? Discuss.

   e) A factor which does not enter into the bean problem but which is basic to the farm-pond problem is the factor of time. Discuss.

Keeping the questions and answers to this problem in mind, see how accurately you can estimate the population in the simulated farm-pond problem.

II. RUNNING THE *TAG* PROGRAM

The computer will ask you to estimate the number of bass in a simulated farm pond through the use of tagging and recovery. At the beginning of the problem the computer will ask you:

```
HOW MANY TAGGED BASS DO YOU WANT FROM THE HATCHERY ?
```

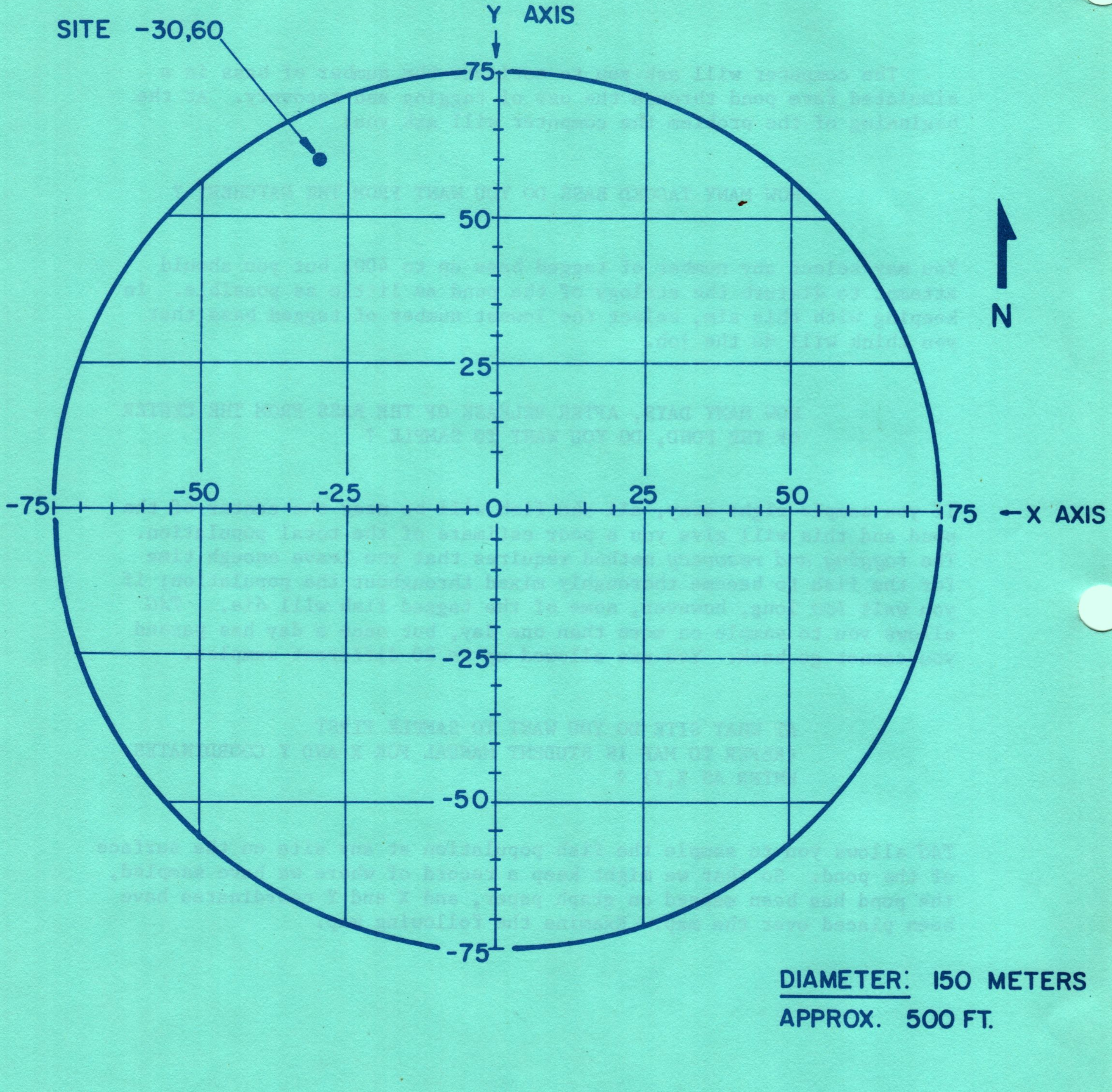
You may select any number of tagged bass up to 400, but you should attempt to disturb the ecology of the pond as little as possible. In keeping with this aim, select the lowest number of tagged bass that you think will do the job.

```
HOW MANY DAYS, AFTER RELEASE OF THE BASS FROM THE CENTER
OF THE POND, DO YOU WANT TO SAMPLE ?
```

If you sample right away, all the fish will be near the center of the pond and this will give you a poor estimate of the total population. The *tagging and recovery* method requires that you leave enough time for the fish to become thoroughly mixed throughout the population; if you wait *too* long, however, some of the tagged fish will die. *TAG* allows you to sample on more than one day, but once a day has passed you cannot go back. You are allowed up to 20 different samples.

```
AT WHAT SITE DO YOU WANT TO SAMPLE FIRST
(REFER TO MAP IN STUDENT MANUAL FOR X AND Y COORDINATES.
ENTER AS X,Y) ?
```

TAG allows you to sample the fish population at any site on the surface of the pond. So that we might keep a record of where we have sampled, the pond has been mapped on graph paper, and X and Y coordinates have been placed over the map. Examine the following map.



COORDINATE MAP FOR FARM POND

Notice that the center of the map has the coordinates (0,0) If you want to sample to the northwest of the center of the pond, you would select the point with the coordinates (-30,60). To help you understand the system, we have labeled this point on the map. If you chose this particular site you would type "-30,60" in answer to this question:

```
AT WHAT SITE DO YOU WANT TO SAMPLE FIRST
(REFER TO MAP IN STUDENT MANUAL FOR X AND Y COORDINATES.
ENTER AS X,Y)  ? -30,60
```

You should select at least five points as sampling sites before you go to the computer. In order to get a good sample, make sure the five points are spread over the entire surface.

Next, the computer will ask:

```
HOW MANY FISH ?
```

You may sample any number of fish at this site. *TAG* assumes that you catch one fish at a time, examine it for the tag and immediately return it to the water. This means that if you catch a large number of fish, you may catch the same particular fish twice.

After you have answered these questions, *TAG* will give you a report on your catch at that station. At the end of the report it will ask:

```
ANOTHER SAMPLE ON DAY (T) (1=YES, 0=NO) ?
```

If you answer with "1" (meaning YES), then you will be asked for a new set of site coordinates and you will be able to sample at this new site. If you answer the above question with a "0" (meaning NO), the computer will ask:

```
DO YOU WANT TO SAMPLE ON ANOTHER DAY (1=YES,0=NO) ?
```

If you answer this question with a yes, you can sample on a later day. If you answer no, the computer will give you the formula for figuring out the total population from your best samples.

The *tagging and recovery* method requires that the tagged fish be uniformly distributed throughout the pond; therefore, a good set of samples should show about the same percentage of tagged fish at each site.

After you have completed your calculations using the data sheet at the end of this manual, you should attempt to estimate the total number of *untagged* fish in the pond. You can obtain a good estimate for the number of untagged fish by averaging the results of your best samples. In general, good samples will yield individual estimates for the total population that come fairly close to agreeing. The computer will ask for this estimate:

```
ENTER YOUR ESTIMATE OF THE UNTAGGED BASS POPULATION ?
```

If your estimate is within 10% of the correct answer, the computer will reply:

```
YOUR ESTIMATE IS GOOD.  CONGRATULATIONS.
```

If your estimate is between 10% and 25% of the correct answer:

```
YOUR ESTIMATE IS CLOSE, BUT NOT WITHIN 10 PERCENT
OF THE ACTUAL POPULATION.
EXAMINE YOUR SAMPLING STRATEGY AND TRY AGAIN.
```

If your estimate is not within 25% of the correct answer, the computer will type:

```
YOUR ESTIMATE WAS NOT WITHIN 25 PERCENT
OF THE ACTUAL POPULATION.
EXAMINE YOUR SAMPLING STRATEGY AND TRY AGAIN.
```

III. PREPARATIONS FOR *TAG*

There are no peculiarities in *TAG*; you should make very few errors the first time you run the program. However, collection and analysis of the data is somewhat more complicated. It is a good idea to record your data on a data sheet like the one included as the last page of this manual.

In any scientific investigation, it is usually good practice to leave as many things as possible constant. In this case it might be wise to use the same sample size throughout the experiment. (Why?) Also, for any scientific experiment, planning is essential. No scientist would ever start an investigation without planning nearly every aspect. Below is a list of things that you should plan before going to the computer to start your investigation:

1) Number of fish to be ordered from hatchery________________

2) Sites to be investigated (select at least 5)

	X	Y	coordinates
SITE A.			
SITE B.			(Use map to figure coordinates)
SITE C.			
SITE D.			
SITE E.			

3) Number of fish to be caught at each station________________

4) First day that sampling will take place________________

DATA SUMMARY SHEET

Number of tagged fish: Q = ______

DAY T	STATION X,Y	SAMPLE SIZE N	TAGGED FISH IN SAMPLE M	UNTAGGED FISH IN SAMPLE N - M	CALCULATED TOTAL POPULATION $P = \frac{N \times Q}{M}$	CALCULATED* UNTAGGED POPULATION P - Q

*Average the results of your best representative samples to get your estimate of the untagged population.